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Synthesis Algorithm for "Quasi-Planar" Dielectric Lenses

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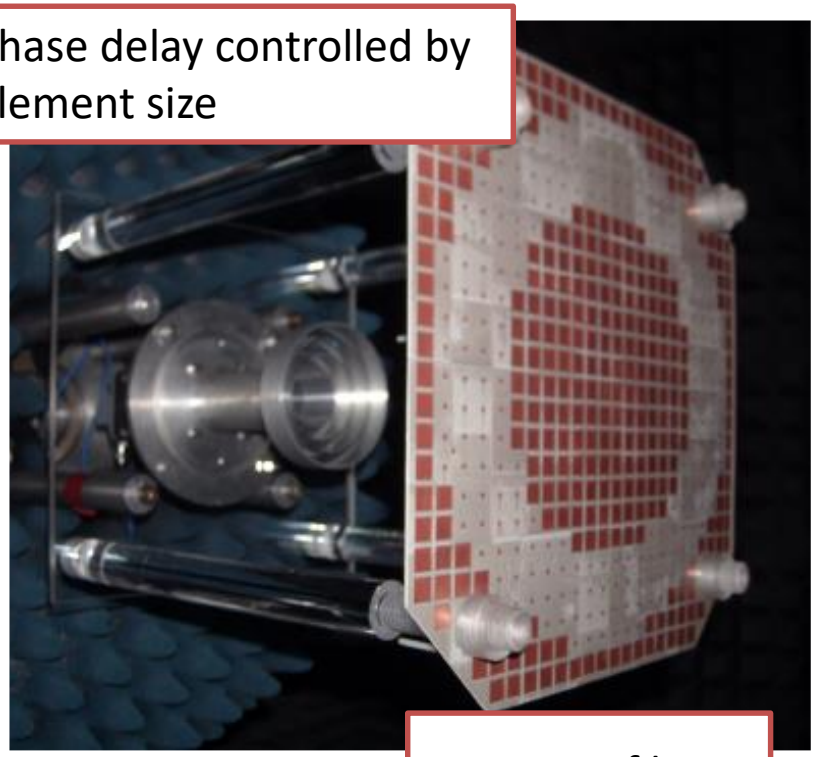
Introduction: Quasi planar lens?

Transmitarray

Phase delay controlled by element size



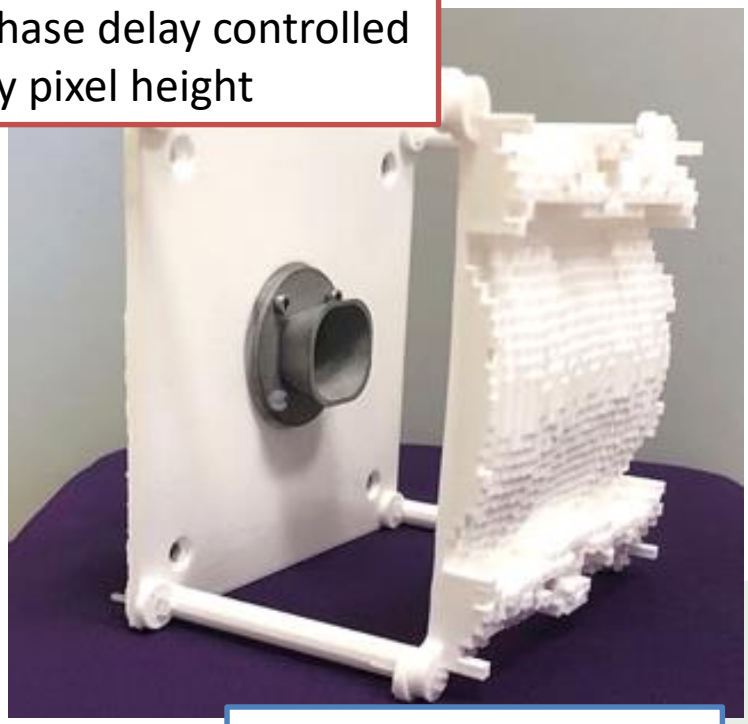
Lower profile

Easy to Model

vs

Quasi –Planar Dielectric Lens

Phase delay controlled by pixel height



Cheaper

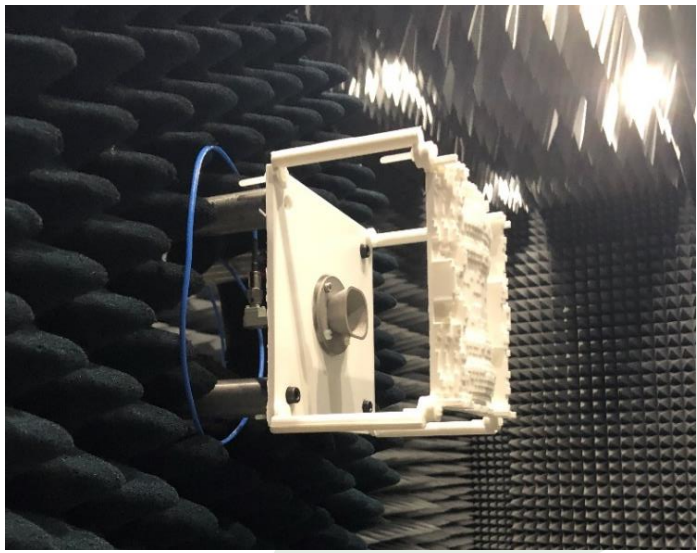
Easy to manufacture

Objetive

Develop a **Synthesis Algorithm** for “Quasi-Planar” Dielectric Lenses

Requierements: fast algorithm based on a accurate model
Phase only algorithm

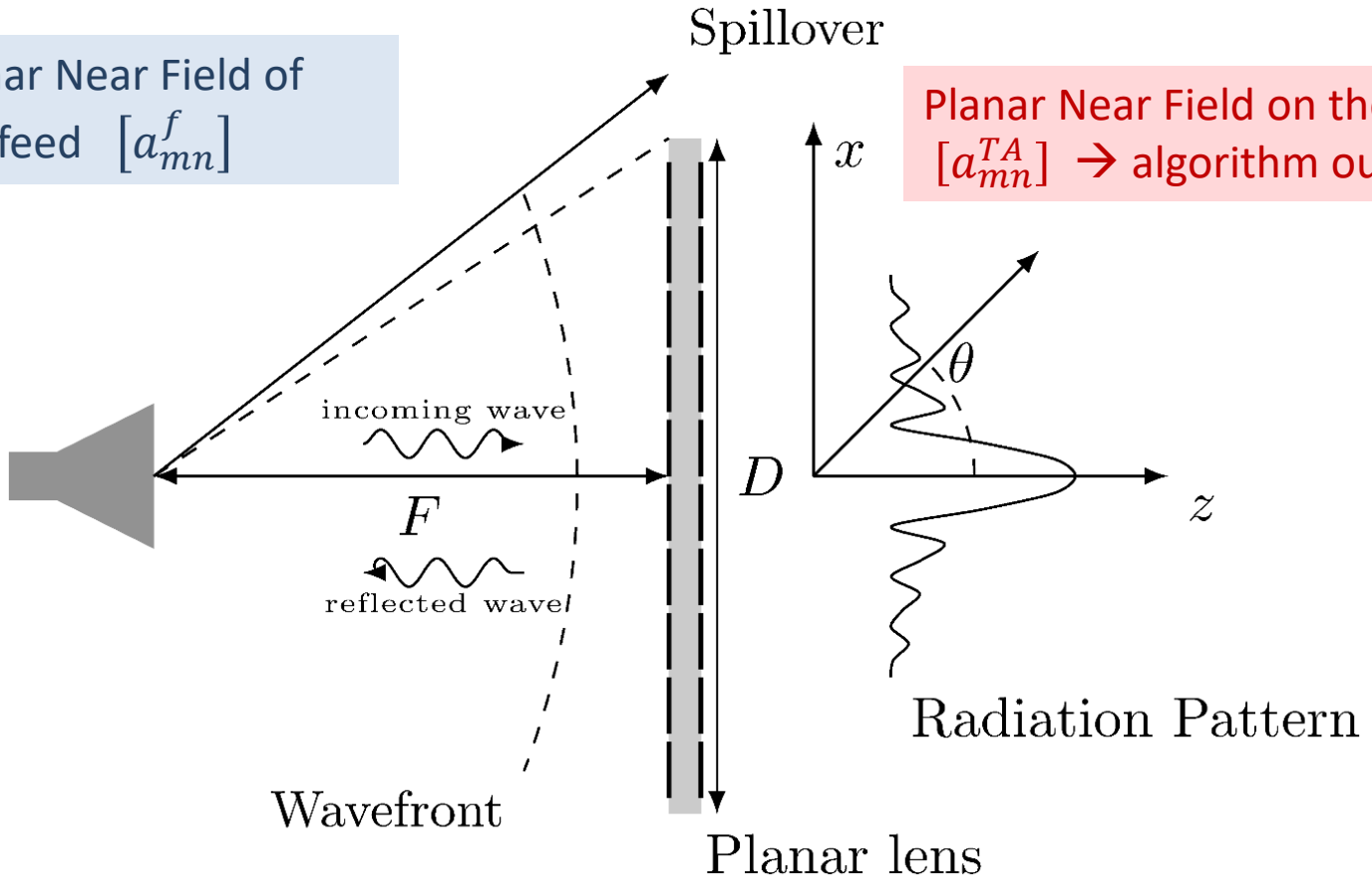
Apply to : Isoflux / Fan / Two Beam / Radiation Patterns
in order to explore the limits of the algorithm



Aperture Model for Planar Lens

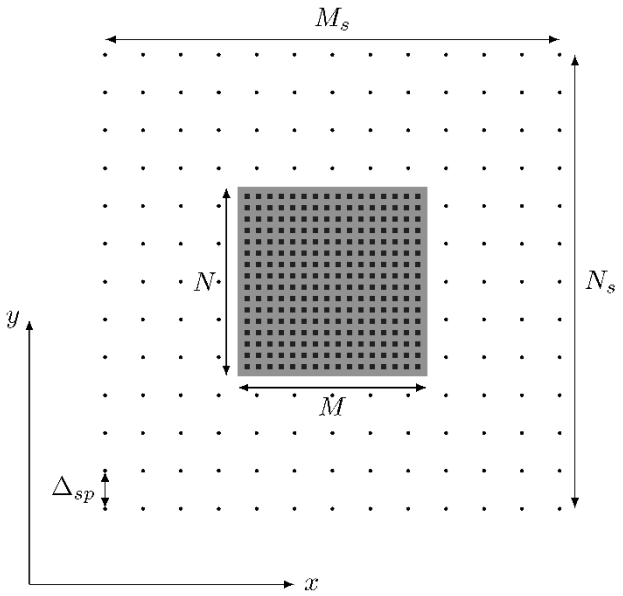
Planar Near Field of the feed $[a_{mn}^{f}]$

Planar Near Field on the aperture, $[a_{mn}^{TA}]$ → algorithm output



Aperture Model for Planar Lens

Aperture Model with spillover effect



$$E^{y}_{total} = (AF_{lens} + AF_{spill})$$

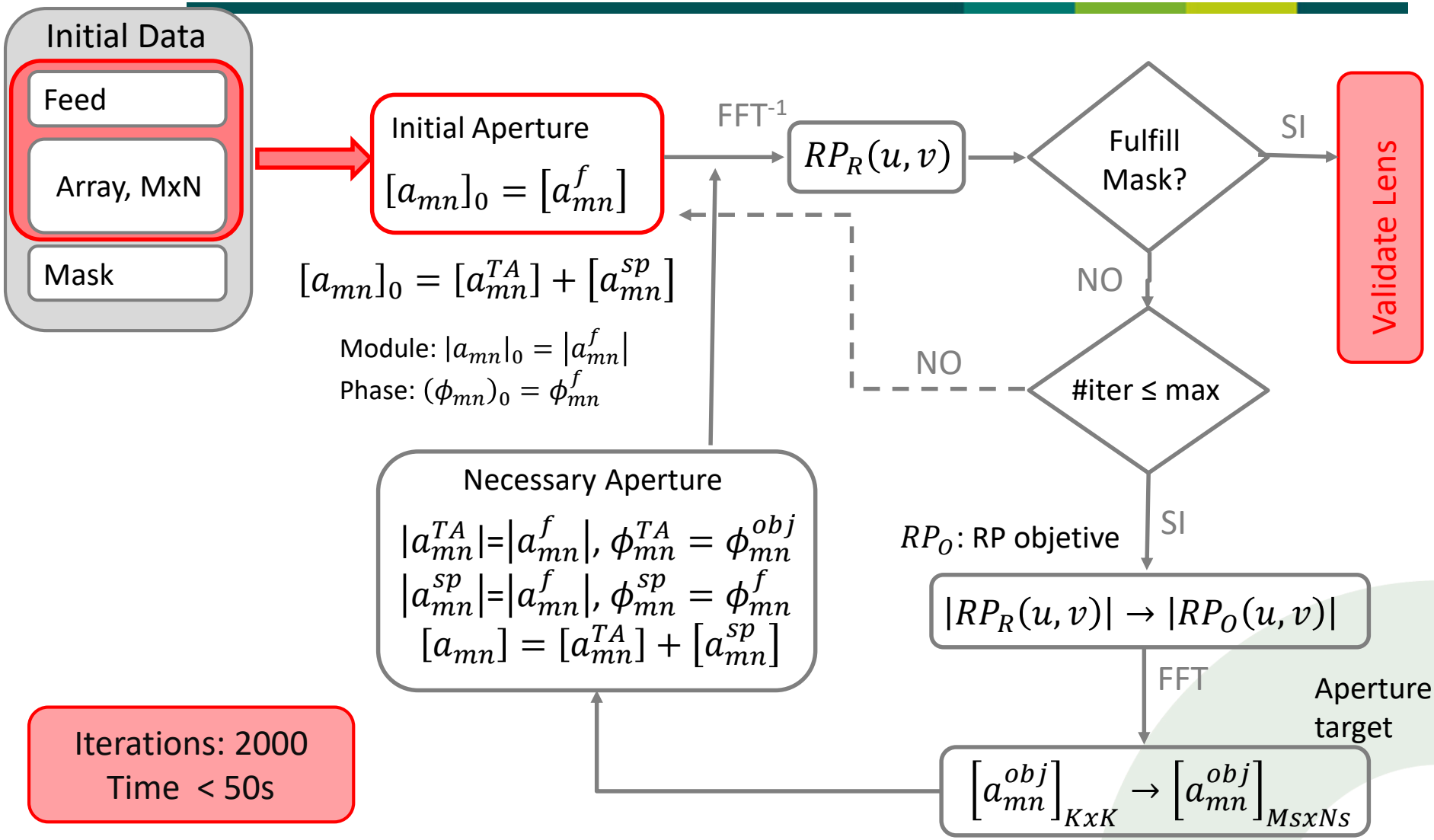
$$AF_{lens} = \sum_{n=1}^{N}\sum_{m=1}^{M} \tau(m,n) a^{f}(m,n) e^{j(m-1)(\Delta_s k_x)} e^{j(n-1)(\Delta_s k_y)}$$

$$AF_{spill} = \sum_{n=1}^{N}\sum_{m=1}^{M} a^{f}(m,n) e^{j(m-1)(\Delta_{sp} k_x)} e^{j(n-1)(\Delta_s p k_y)} \cdot u(m,n)$$

$$u(m,n) = \begin{cases} 1, \text{ if outside the lens} \\ 0, \text{ if inside the lens} \end{cases}$$

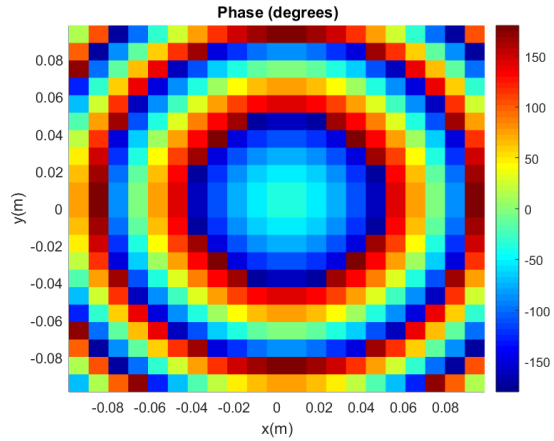
$$a^{TA}(m,n) = \tau(m,n) a^{f}(m,n)$$

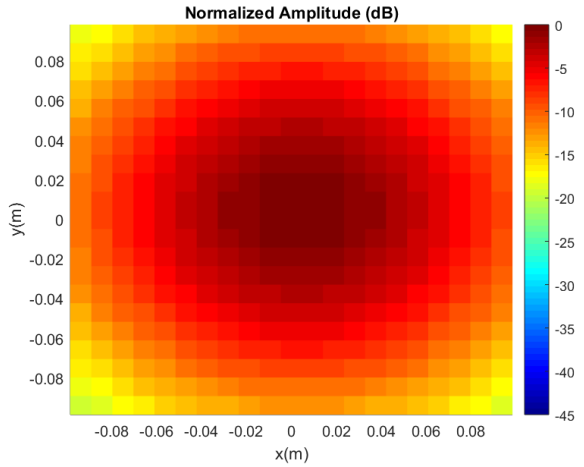
Synthesis Algorithm for Planar Lens



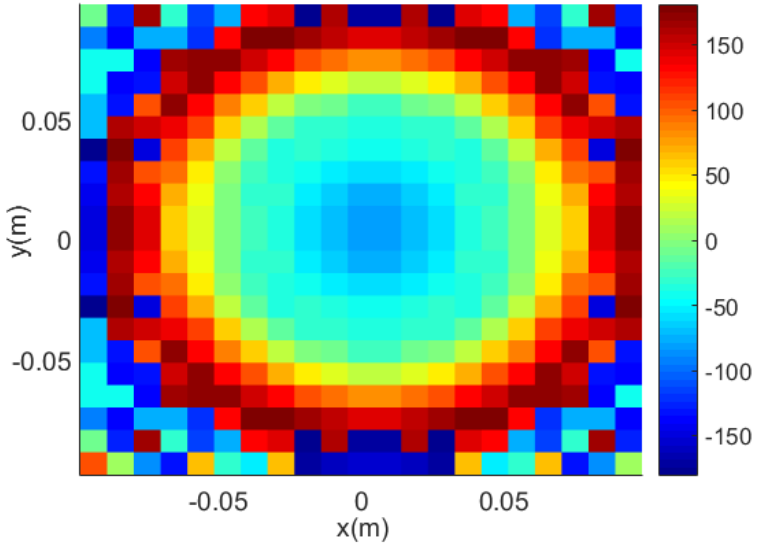
Rectangular Radiation Pattern

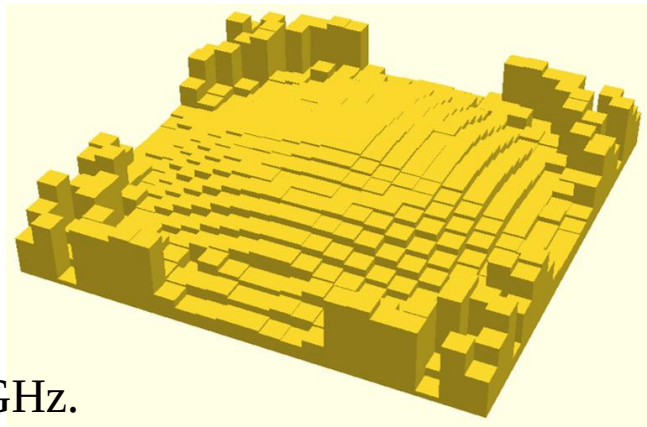
Planar Near Field of Feed





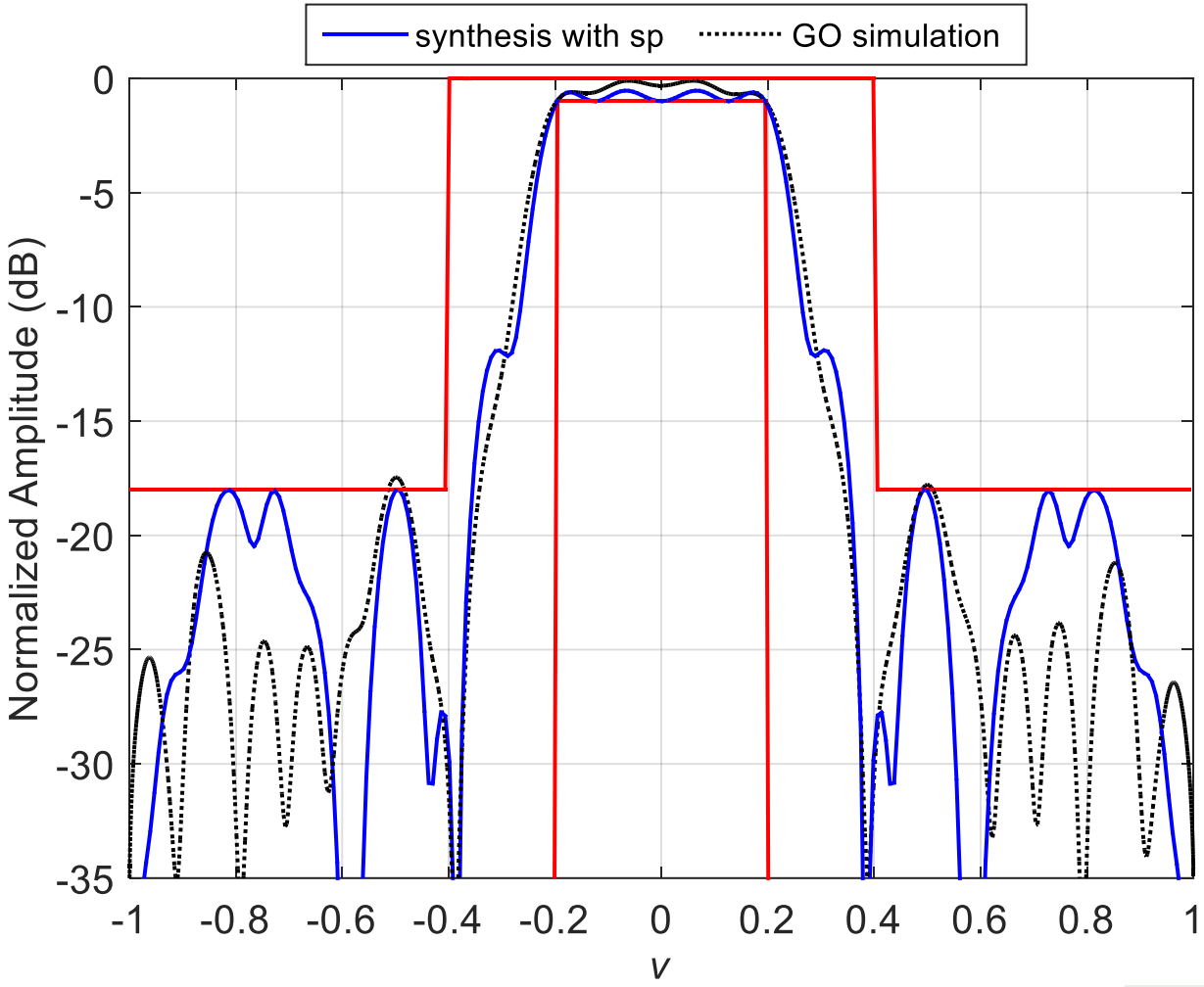
Synthetized



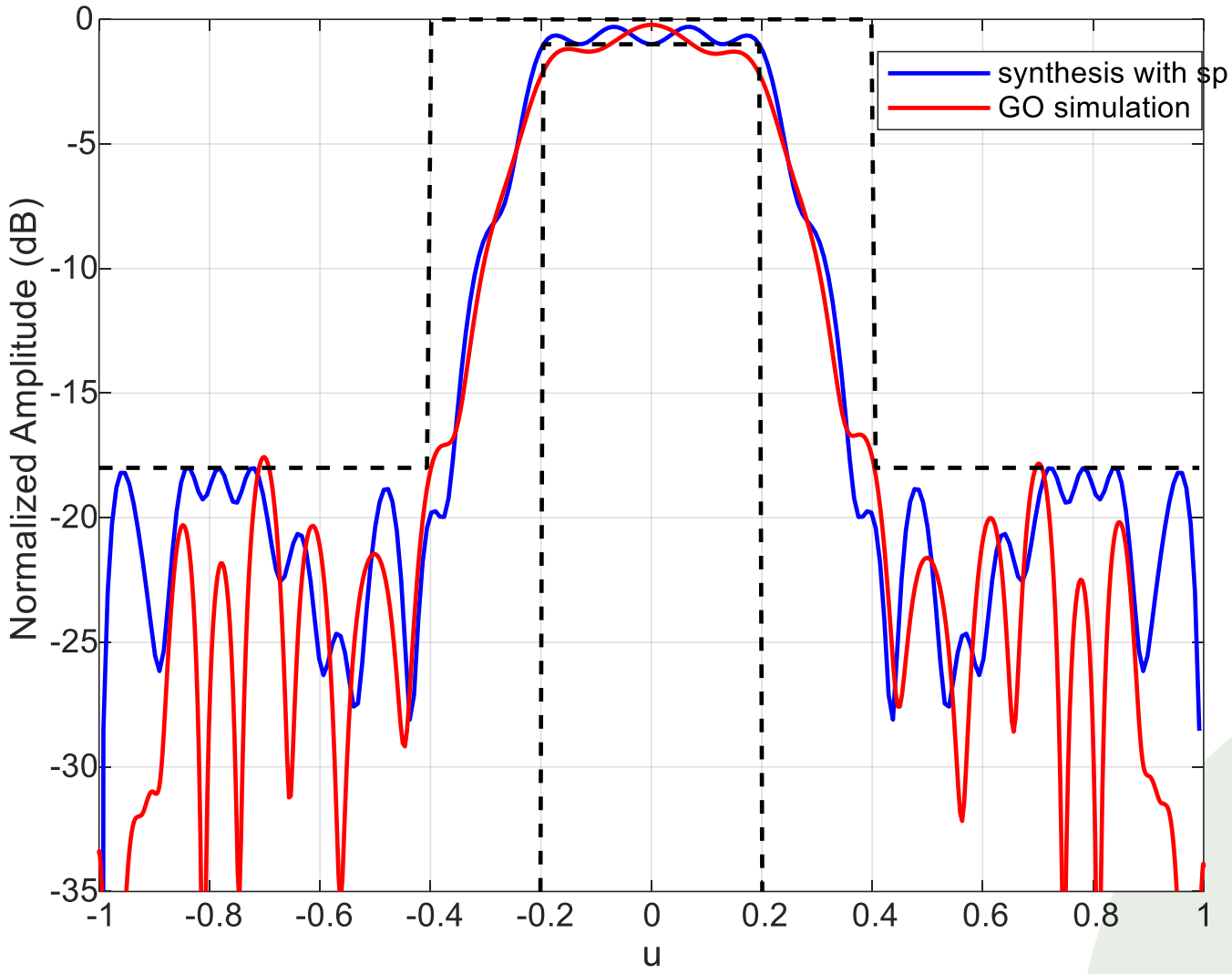


38×38 unit cells, also with a periodicity of 0.5λ at 16 GHz.

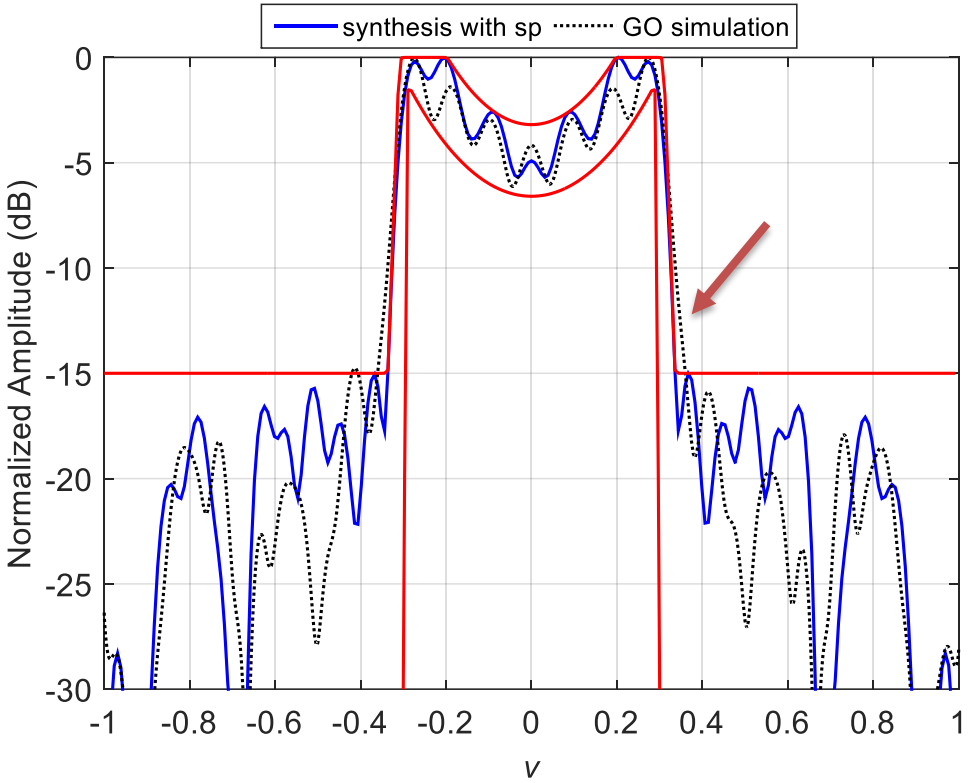
Rectangular Radiation Pattern

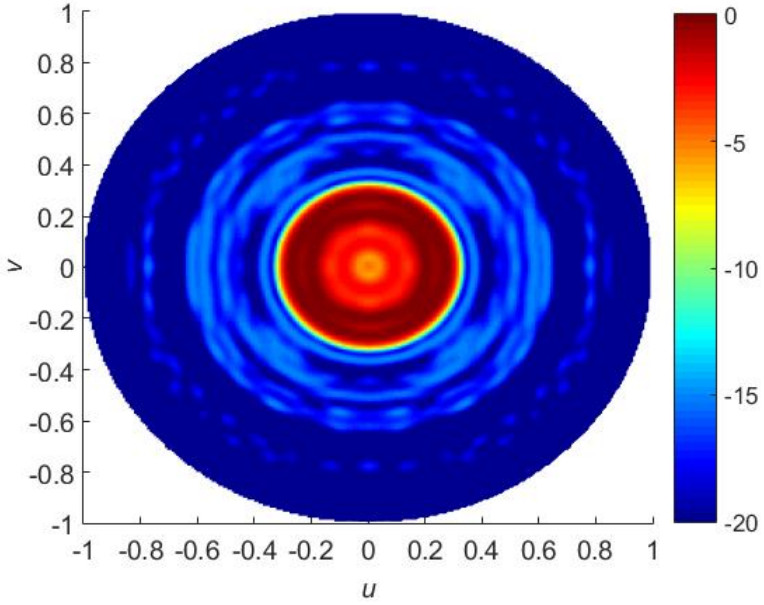


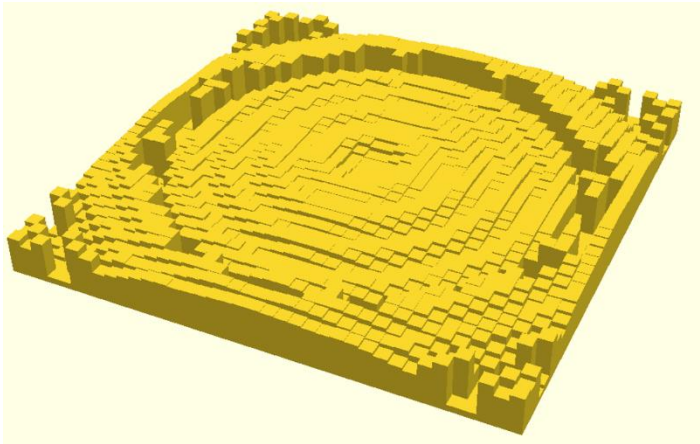
Rectangular Radiation Pattern



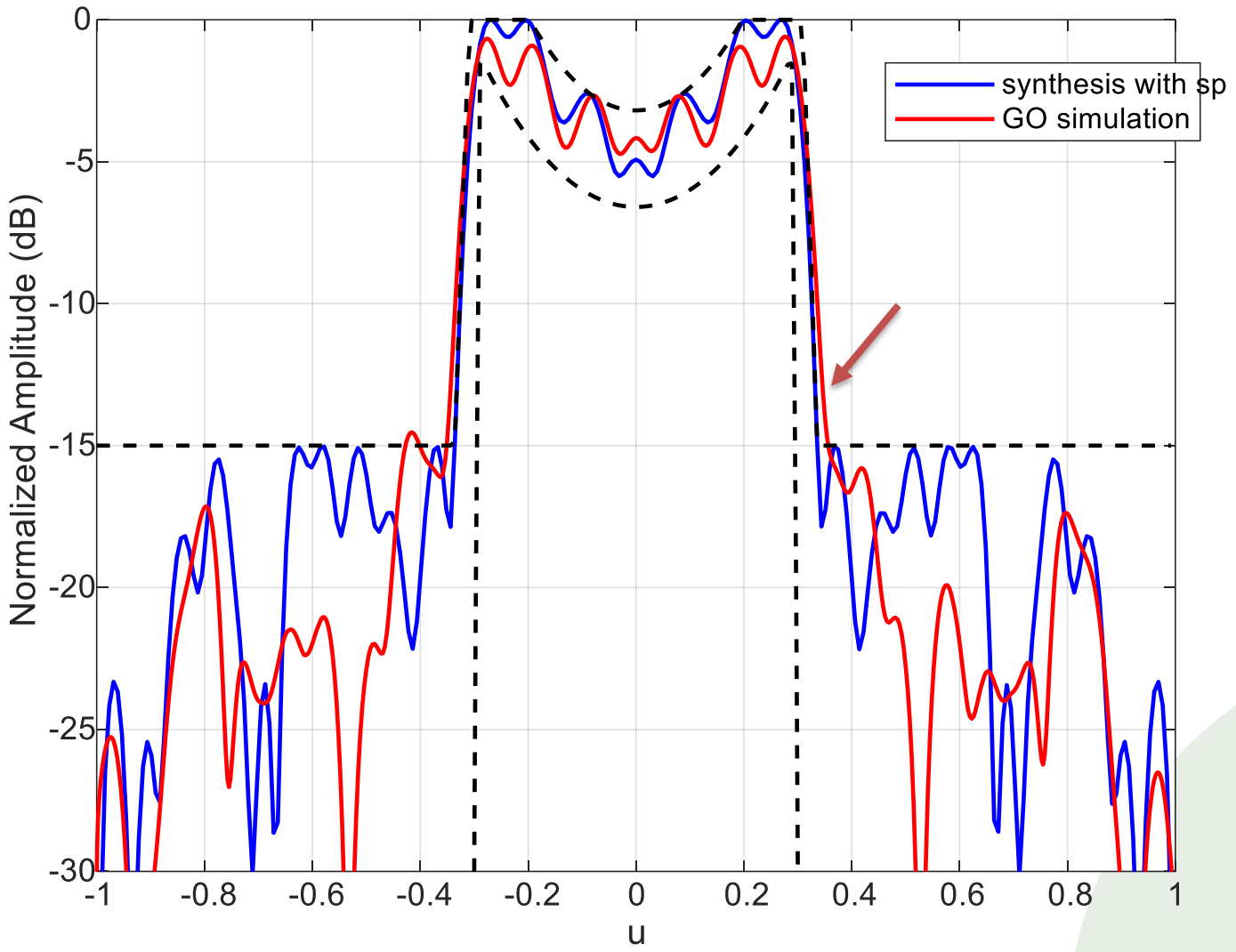
Isoflux Radiation Pattern







Isoflux Radiation Pattern



Synthesis Algorithm for Planar Lens (2)

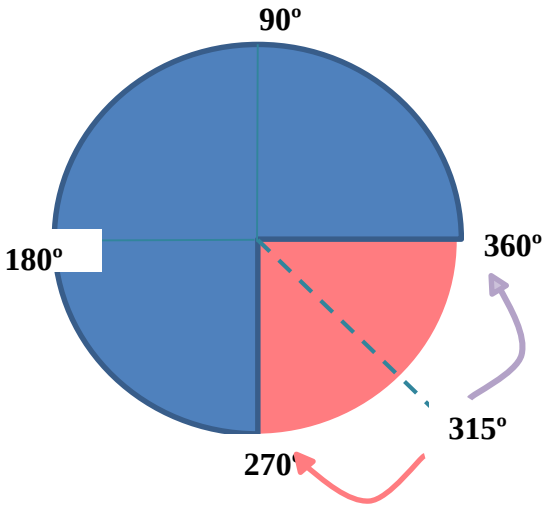
Stage 1

Phase 360º

Stage 2

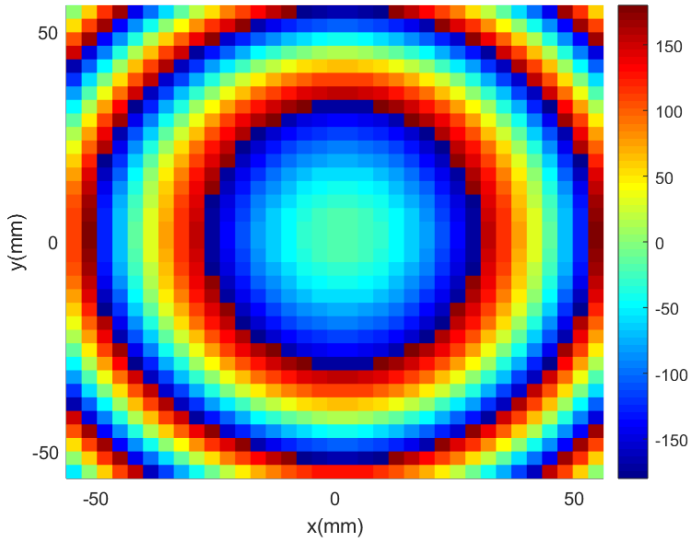
Reduction of profile
Decrease shadowing effect
Decrease weight

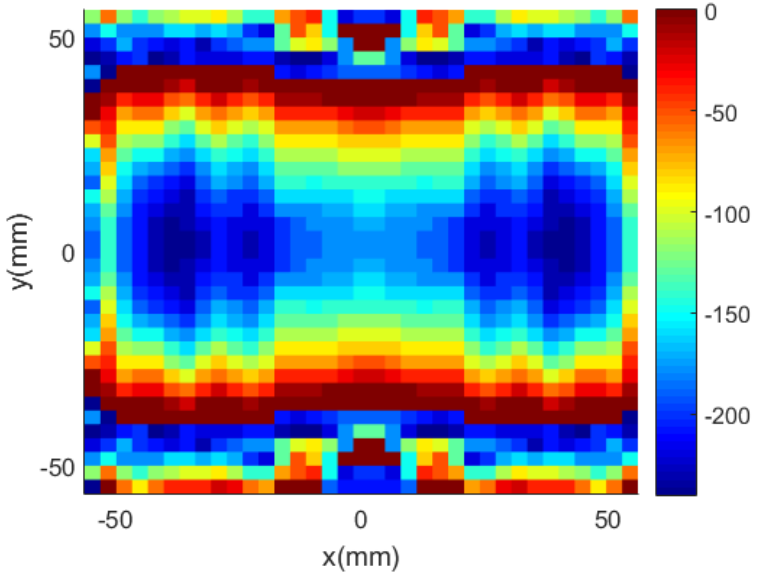
Phase 270º

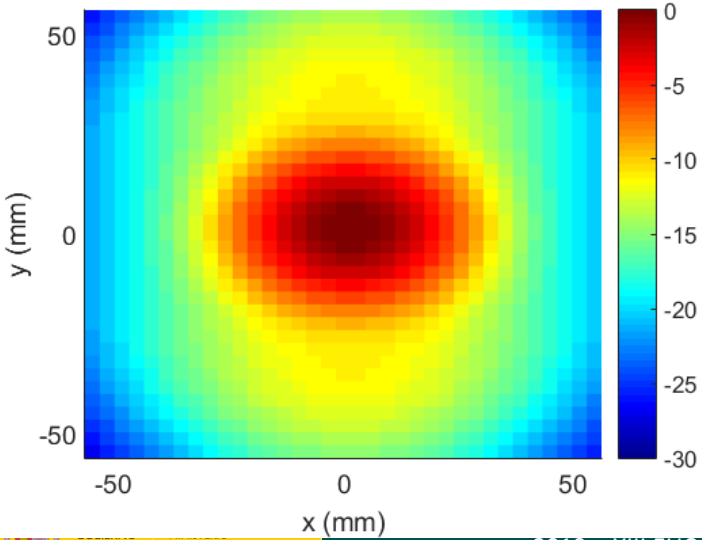


Final Design

Fan Radiation Pattern

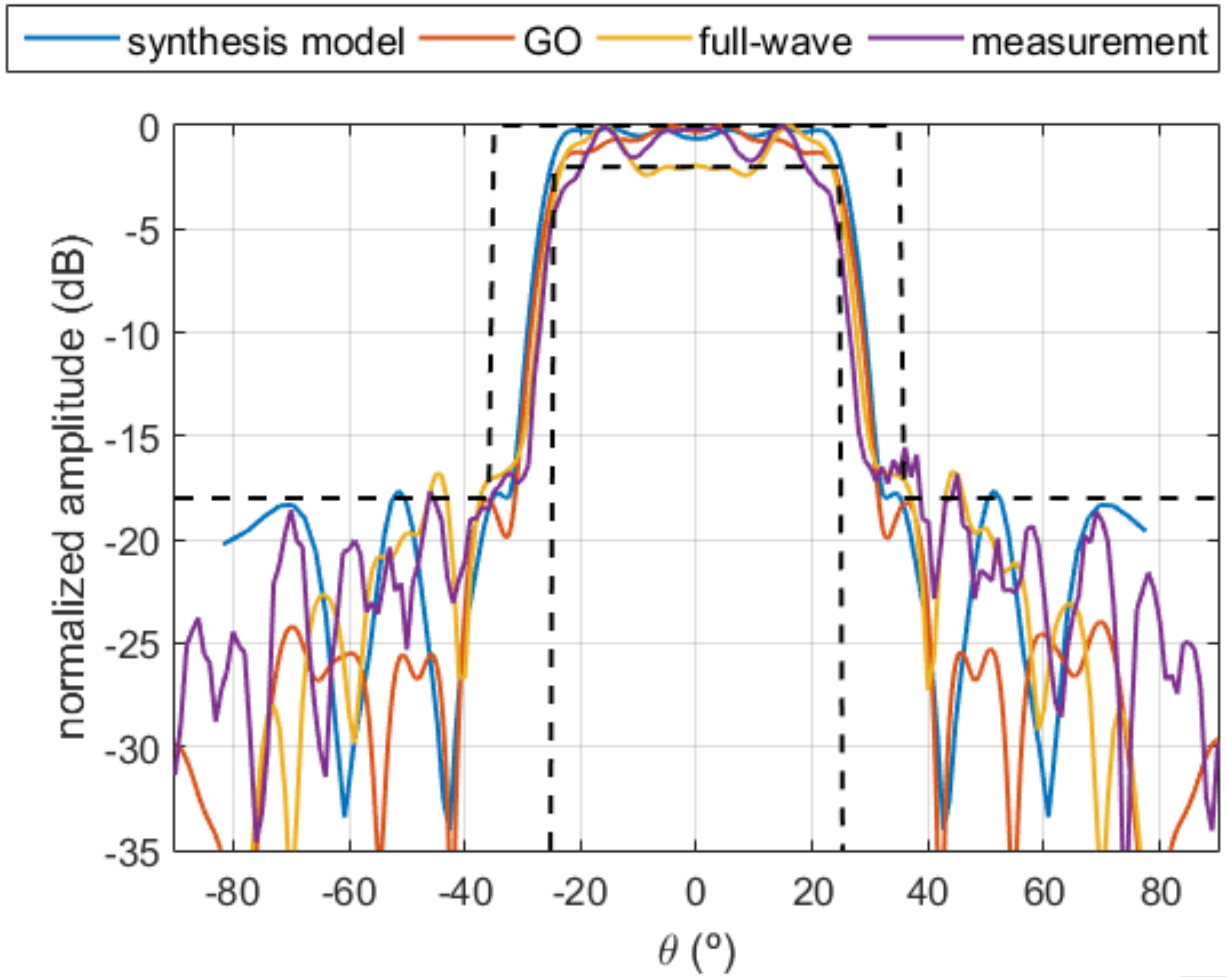




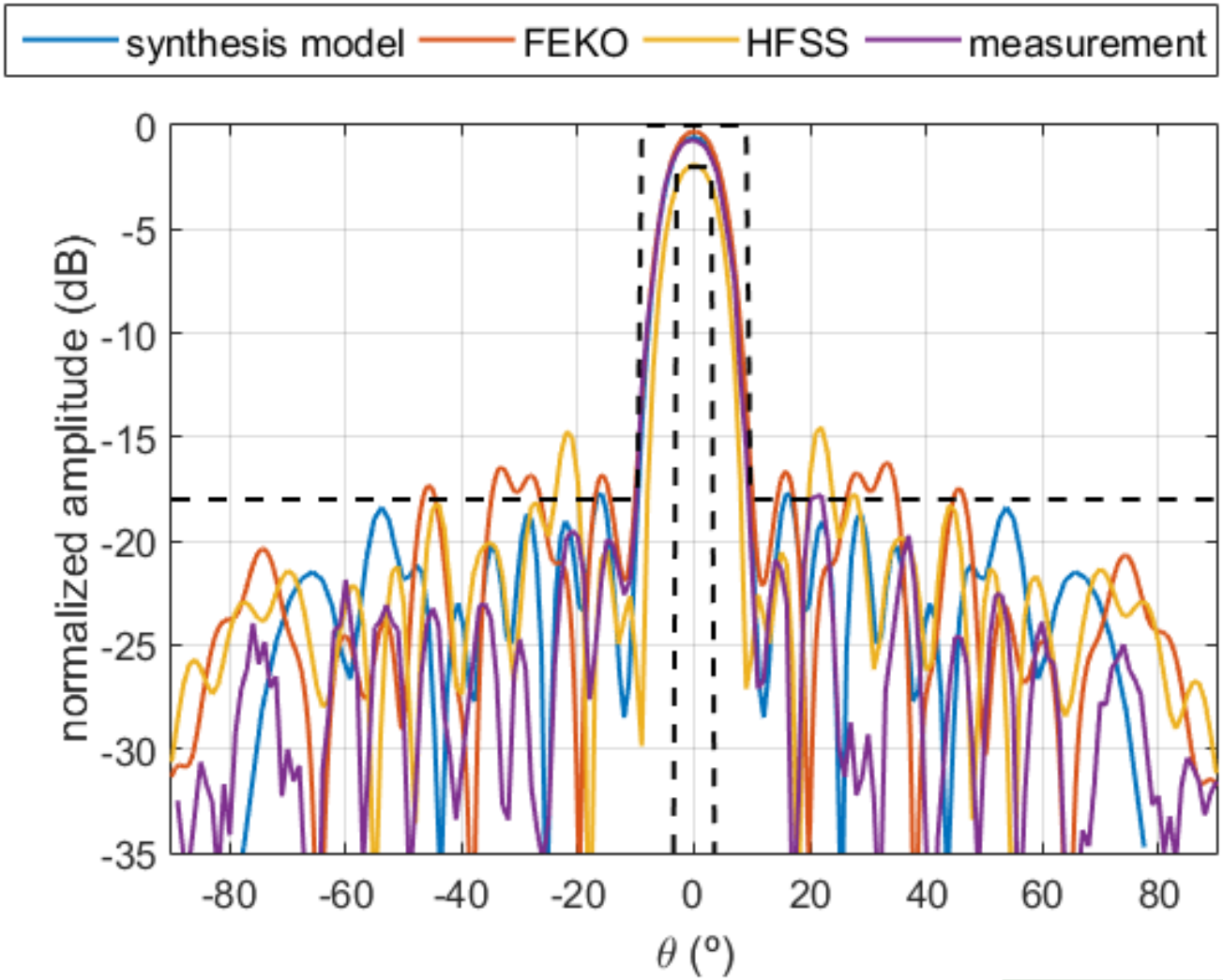


36x36 elements $0.3\lambda \times 0.3\lambda$, 28 GHz

Fan Radiation Pattern

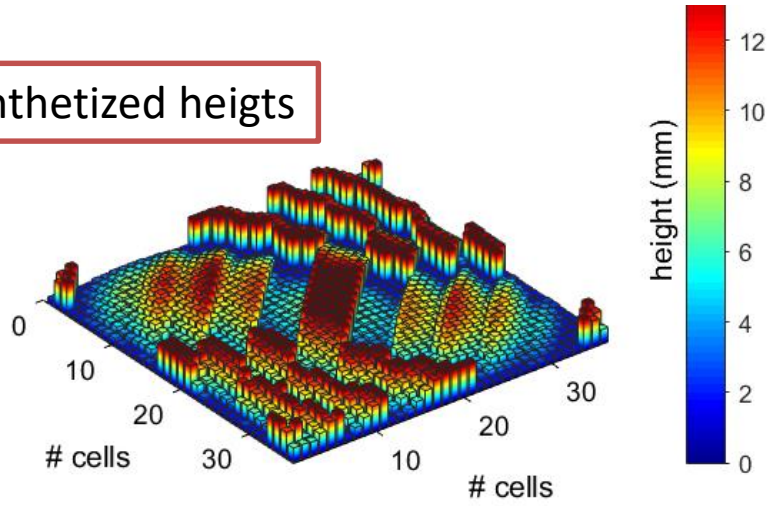


Fan Radiation Pattern

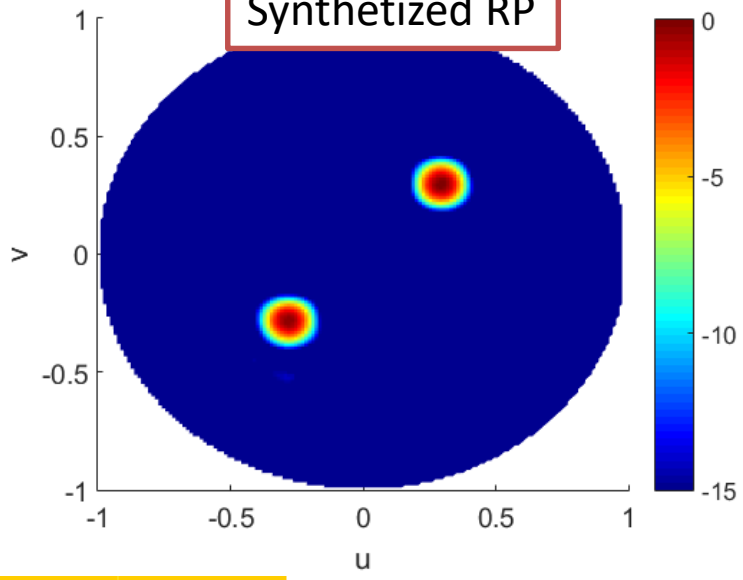


Two Beams Radiation Pattern

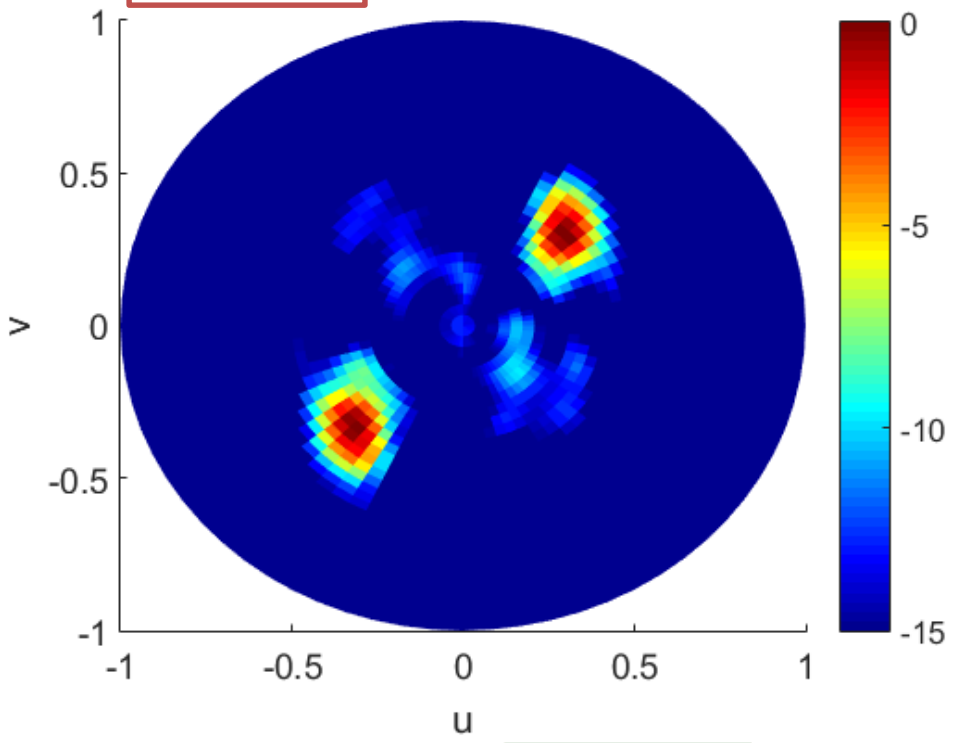
Synthetized heigts



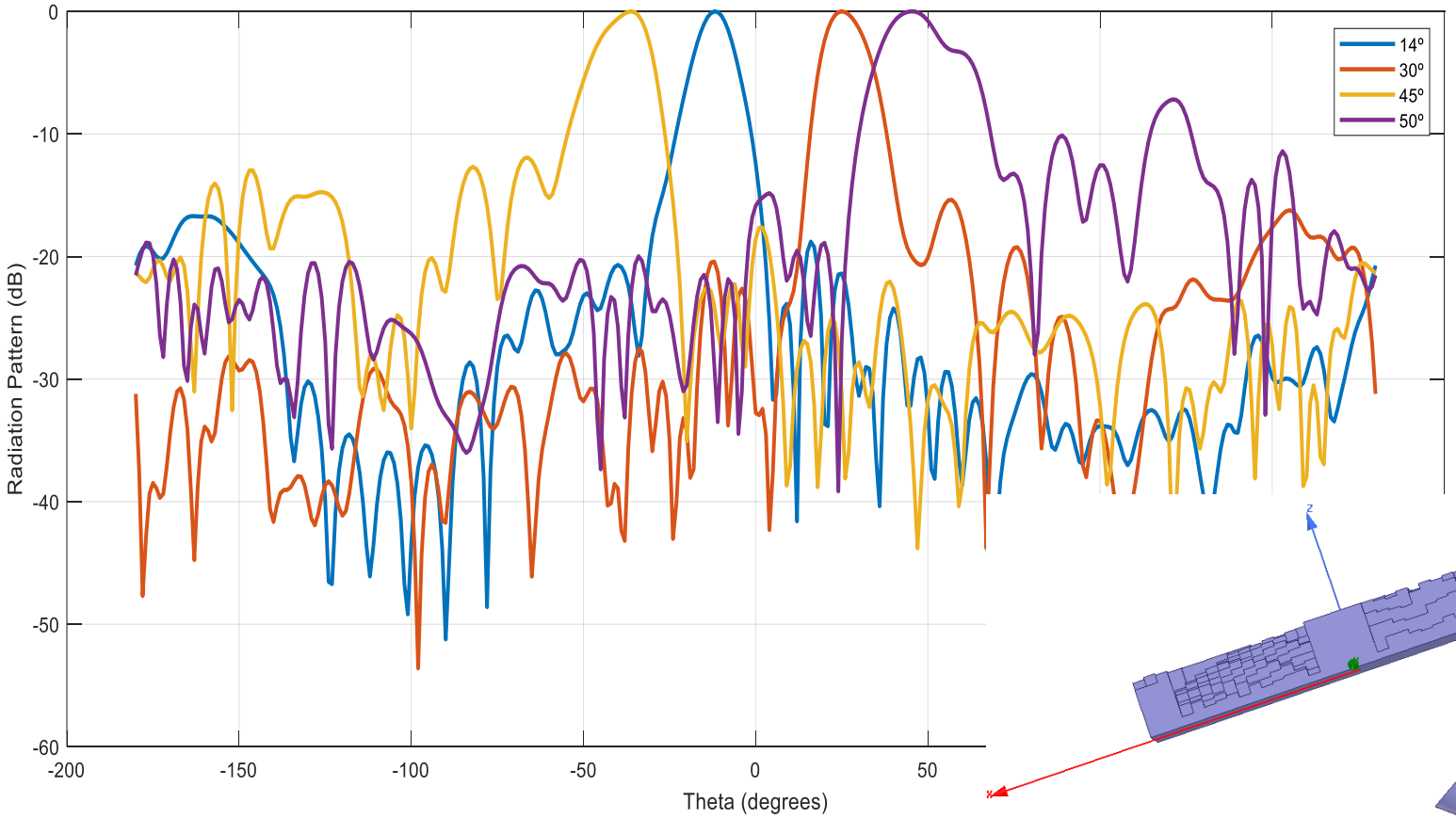
Synthetized RP



Simulated



MultiBeam Radiation Pattern



Conclusions

- It is possible to synthetize shaped radiation patterns with quasi-planar dielectric lenses
- An algorithm based on a planar array model and using FFT / has been developed.
- The algorithm has been improved reducing the necessary delay of each cell (pixel)
- This improvement reduces also the profile, material and time of manufacture.
- This algorithm has been verified with different radiation pattern.
- Good fitting between model, simulation and measurement has been found

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Acknowledgement

GOBIERNO DE ESPAÑA
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